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By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

M.K. Hawkins

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

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[X] *Additional inventors are being named on the* 2 *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

COPLANAR CAMERA

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ENCLOSED APPLICATION PARTS *(check all that apply)*

[X] Specification *Number of Pages* 7 [ ] Small Entity Statement

[X] Drawing(s) *Number of Sheets* 3 [X] Other (specify) Express Mail Certificate and a Fee Transmittal Form

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

[X] A check or money order is enclosed to cover the filing fees. Our Order No. 1522.

[ ] The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 22-0493

FILING FEE AMOUNT ($): $150

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

[X] No.

[ ] Yes, the name of the U.S. Government agency and the Government contract number are: ____

Respectfully submitted,

Date 3/17/00

SIGNATURE ____

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REGISTRATION NO. *(if appropriate)* 37,633

Docket Number: ASI-PT052

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C., 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C., 20231.

PROVISIONAL APPLICATION COVER SHEET
Additional Page

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Docket Number	ASI-PT052	Type a plus sign (+) inside this box →	+

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Number 2 of 2

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Attorney Docket No. ASI-PT052

COPLANAR CAMERA

Field of the Invention

The present invention relates generally to optical scanning systems. More particularly, this invention relates to a scanning system containing a coplanar camera utilizing a LED array light source.

Description of Related Art

Various optical scanning systems have been developed for reading and decoding coded symbologies, identification of objects, comparison of objects, and measurement of objects. Each of these scanners utilize either a non coherent or coherent light source. Lighting is one of the key elements in obtaining good image quality. The intensity of light needed for an application is directly proportional to the speed of the transport and the speed of the sensor. The faster an image is acquired, the more light is needed. Until now only high intensity sodium or halogen lighting was adequate to obtain crisp images in cameras that focus over a depth of field at high speeds. This light source is usually located off axis from the camera and sensor detecting the light reflected from the object being scanned.

In applications using a non coherent light source, such as sodium lamps, the light source is used to provide the illumination required by the camera detection means. These lamps provide an abundance of optical power because they are very bright and have a wide

spectral range. There are several disadvantages to light sources such as sodium lamps. First, due to their extreme brightness, they can create an annoyance and even a hazard to workers working in the vicinity of the scanning systems. Additionally, this type of light source requires a large power supply, and hence more AC power, and it creates a large amount of heat. Other problems are the creation of RFI emissions which can present operational problems to equipment in the vicinity of the scanning system.

The use of LEDs present several advantages. LED illumination is a more cost effective and ergonomic method of illumination than the traditional sodium or halogen illumination. The problem presented by LED illumination is how to get enough light to the object that is being imaged when focusing over a 36" depth of field. By eliminating the mounting angle between the illumination and the line of sight of the camera, the return light is managed and a lower intensity light source may be used. First, since they can be energized almost instantaneously, they can be de-energized when objects are not being transported within the field of view. This extends the life of the LEDs and also conserves power. Additionally, the power to individual LEDs maybe modulated and pinpointed in a certain area, such that different LEDs within an LED array may be energized at different levels according to the desired application.

Accordingly, there exist a need for a camera which detects light from a smaller and simpler light source while still providing the ability of detection over a large depth of field.

SUMMARY OF THE INVENTION

The present invention is a system which utilizes a LED array which is located coplanar to the camera lens and light sensor. The coplanar design concept permits the use of LED illumination with a camera for barcode reading applications requiring focusing. The coplanar design will provide adequate illumination of a 30" DOF at low speeds. The next developmental milestone will include the ability to cover a large DOF at high speeds.

The design moves the light source relative to the line of sight of the camera. Traditionally, the light source is at an angle relative to the line of sight of the camera. Due to this angle the cross section of the light pattern has to be relatively wide, and the intensity of light must be high to provide enough light to properly illuminate a full 36" DOF. With illumination that is coplanar to the line of sight of the camera the illumination profile can be very tight and the intensity of light required to illuminate over a DOF will be significantly reduced, thus allowing for the use of an LED array.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a drawing of a side view of the coplanar camera in accordance with the preferred embodiment of the present invention.

Figure 2 is a drawing of a top view of the coplanar camera in accordance with the preferred embodiment of the present invention.

Figure 3 is a drawing of a front isometric view of the coplanar camera in accordance

with the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The first embodiment of the present invention will be described with reference to the drawing figures wherein like numerals represent like elements throughout.

Referring to Figure 1, a coplanar camera 10 made in accordance with the present invention is shown. The coplanar camera 10 includes a linear array of LEDs 11, a camera lens 12, a focusing ring 13, a linear array sensor 14, a window 22, a cylindrical lens 18, and a voice coil actuator 16.

The coplanar camera 10 utilizes a CMOS linear array sensor 14 to detect the light reflected from the object being scanned. In the preferred embodiment of the present invention, a CMOS-based image sensor will be referenced, but as those skilled in the art should know, any image sensor may be utilized, e.g., a CCD based image sensor. The light reflected onto the CMOS linear array sensor 14 is generated by an array of very high intensity light emitting diodes (LEDs) 11. The preferred embodiment of the present invention utilizes red LEDs within the array, but as known to those skilled in the art, as the technology regarding LEDs advances, brighter, more intense LEDs can be used or LEDs having a different wave length.

This LED array 11 acts as the light source for the coplanar camera 10. As shown in Figure 2, in the preferred embodiment of the present invention, the LED array 11 is

sitioned parallel to, and in the same plane as, the CMOS linear array sensor 14. Those skilled in the art should realize that the LED array 11 (light source) positioned in this manner is "on-axis" with the CMOS linear array sensor 14. The LED array 11 comprises a plurality of LEDs in series with each other, located on a PC Board 31. In the preferred embodiment, the coplanar camera utilizes two LED arrays to generate the required amount of light. The LED arrays 11 are positioned at each side of the camera lens 12. As should be clear to those skilled in the art, the number of LEDs required for each LED array 11 differs based on the size of the conveyor belt and required depth of field. The present invention utilizes 50 LEDs in each of the two LED arrays 11, totaling 100 LEDs.

The light emitted from the LED arrays 11 is focused to a narrow "stripe" on the object using a cylindrical lens 18. This cylindrical lens 18 is positioned parallel to and in between the LED array 11 and the object. A cylindrical Fresnel lens is utilized in the present invention, but as those skilled in the art should realize, any cylindrical lens can be used. As shown in Figures 1 and 2, the positioning of the cylindrical lens in relation to the LED array 11 provides a narrow "stripe" of light anywhere within the depth of field. When an object enters this field, the illumination from the LED arrays 11 is focused upon the object. Because of the positioning of the sensor relative to the LED array light source 11, the CMOS linear array sensor 14 detects the most intense light provided by the LED array 11, that which is towards the center of the entire light source 11, independent of the distance to the object.

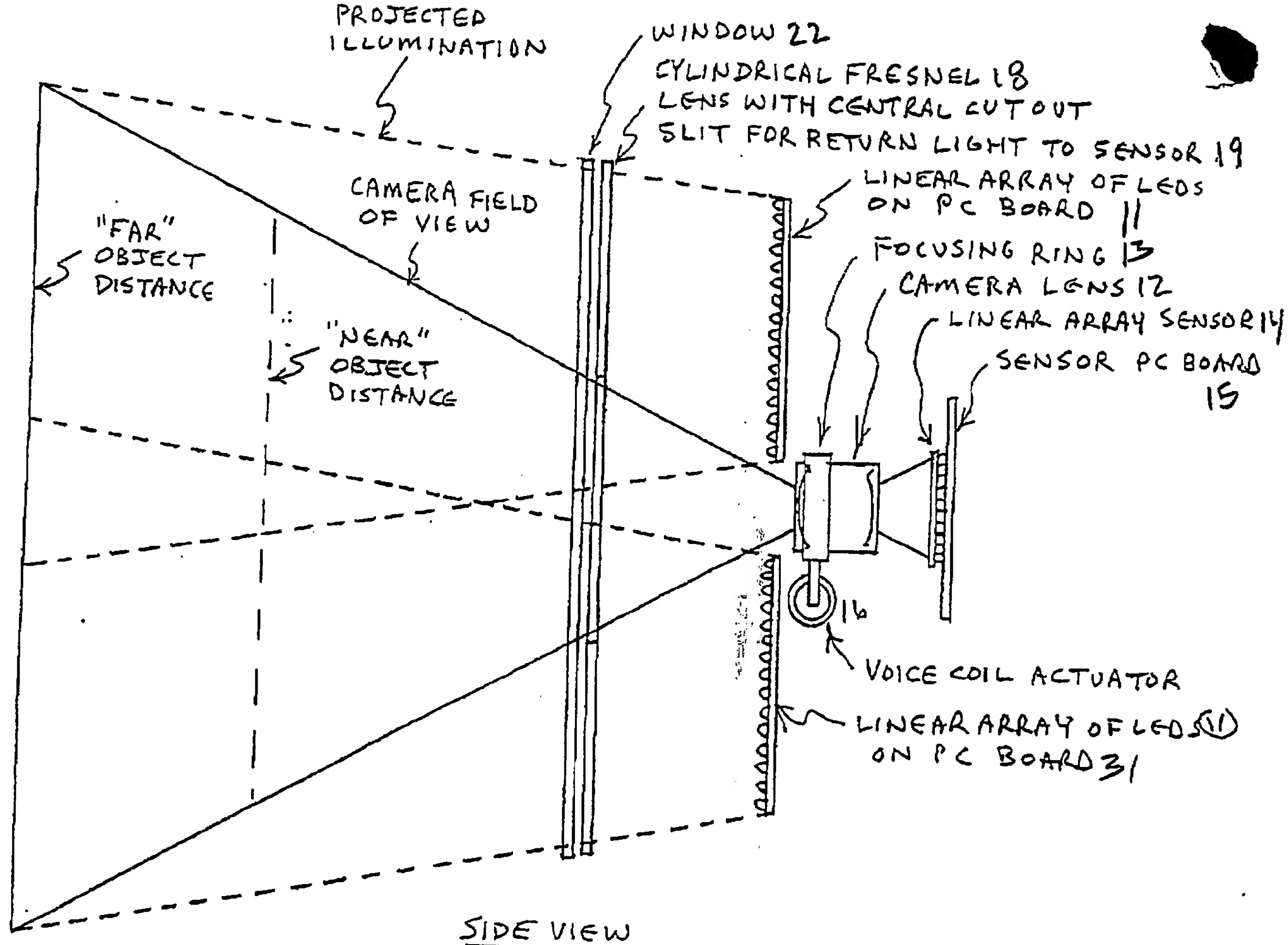
The cylindrical lens 18 includes a center slit 20. This slit 20 permits the light reflected from the object to return through the cylindrical lens 18, without being focused, to the camera lens 12 and then projected onto the CMOS linear array sensor 14.

In order to maximize the depth of field of the coplanar camera 10, the voice coil actuator 16 is coupled to the focusing ring 13 of the imaging lens 12 to dynamically focus the image onto the CMOS linear array sensor 14, based on a signal from a range finder (not shown). Those skilled in the art should realize that there are many methods and apparatuses that can be used as range finders. The signal received from the range finder causes the voice coil actuator 16 to move the camera lens 12 and focus the light reflected from the object onto the linear array sensor 14.

An alternative embodiment of the present invention utilizes a focusing mechanism for the LED array to more accurately focus the emitted light onto the object. This enhances the image which is received by the camera lens 12 and projected onto the CMOS linear array sensor 14. The LED focusing mechanism is coupled to the LED array 11, and dynamically moves the position of an LED focusing lens with respect to the position of the LED array. It should be noted that either the LED focusing lens or the LED array 11, or both, may be moved to focus the light. Such movement, of course, depends on the distance of the object from the camera 10. This alternative embodiment keeps the intensity of the illumination stripe maximized at any distance, providing a cleaner image detected by the CMOS linear array sensor 14.

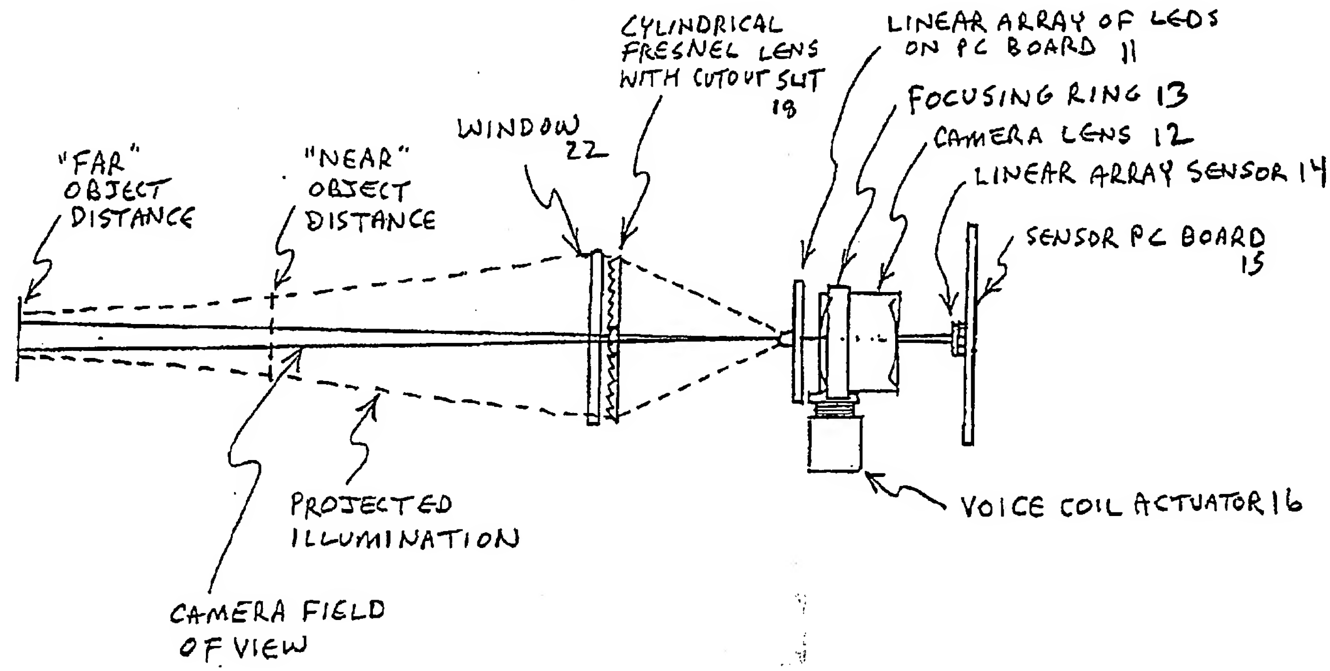
While specific embodiments of the present invention have been shown and described, many modifications and variations could be made by one skilled in the art without departing from the spirit and scope of the invention. The above description serves to illustrate and not limit the particular form in any way.

* * *



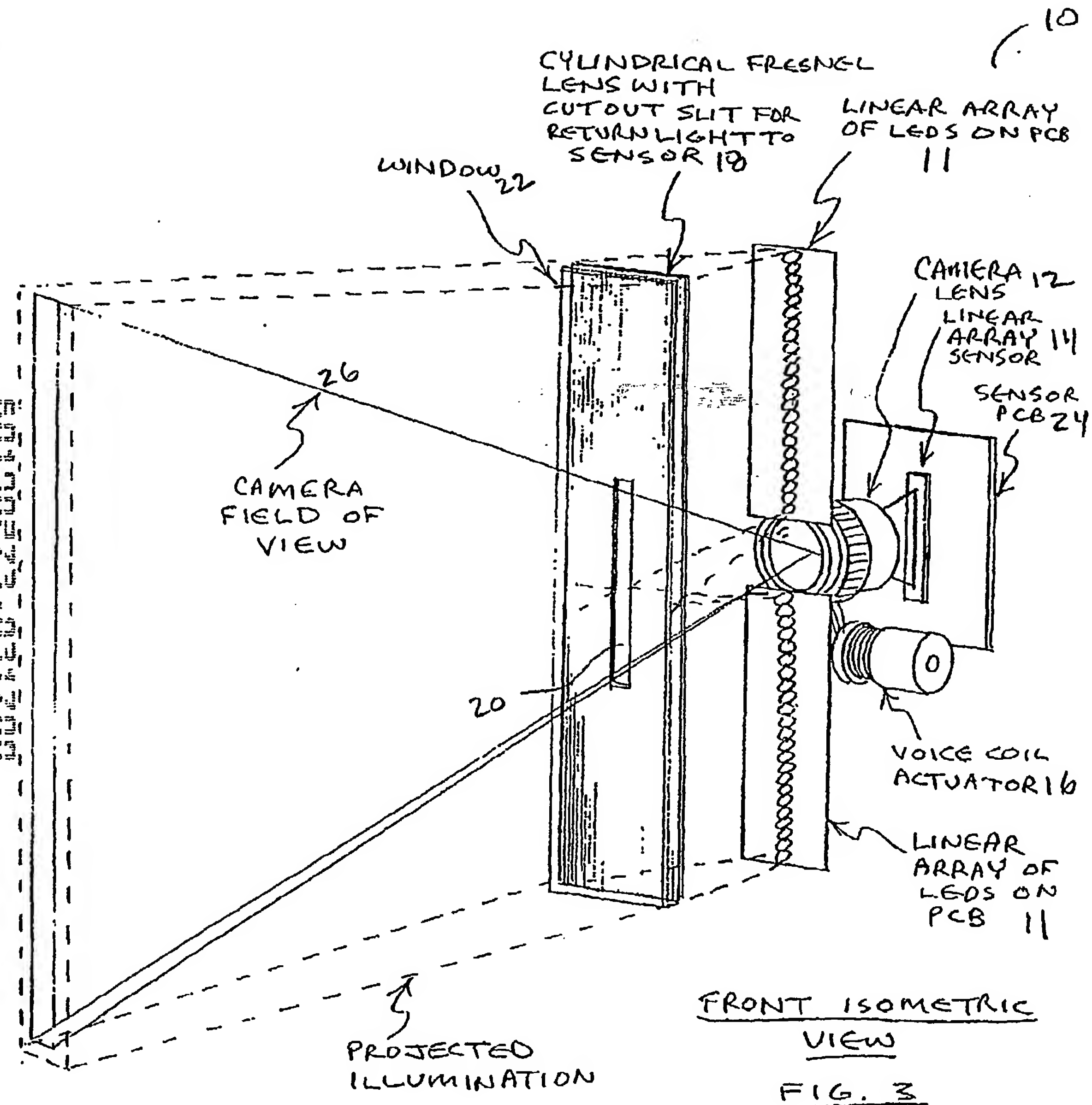
SIDE VIEW

FIG. 1



TOP VIEW

FIG. 2



FRONT ISOMETRIC VIEW

FIG. 3